On a New Species of Corymorpha from Japan (*C. tomoensis*).

BY

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(*With Plate V*).

During a short stay, in September of 1907, at Tomo in the Province of Bingo, about fifty specimens of a solitary hydroid of the genus *Corymorpha* were collected by me by means of a trawl. Through assistance of Mr. A. Izuka of the Tokyo Imperial University and of Dr. H. B. Torrey of the California University, I was enabled to ascertain that this form is new to science. It is my pleasant duty here to express my hearty thanks to both the gentlemen for their kindness rendered me. I also owe a great obligation to Mr. Arii, post-graduate of the Hiroshima normal school, who assisted me not only in collecting the material but also in investigating the mode of budding, the discovery of which should be credited to him.

Corymorpha tomoensis n. sp.

The general aspect of the entire hydrosome (Fig. 1) bears a great deal of resemblance to that of *Corymorpha nutans*.[1] The measurements of the larger individuals in the fresh state are as follows:

Total height of the hydrosome .... 40–50 mm.
Height of the hydranth .... 8–10 mm.
Maximum breadth of the hydranth .... 4.5 mm.
Maximum breadth of the hudrocaulus .... 3–4 mm.

According to Allman's description, *C. nutans* seems to be a little

1) Allman, G. J.,—A. Monograph of the Gymnoblastic or Tubularian Hydroids. (1871).

larger than the present species, as the hydrocaulus of the former is said to be 2–3 inches (50–75 mm) long and 2 lines (4. 5 mm) thick in the most swollen parts. As to the colouration of the hydrosome, the present species differs remarkably from any of the species hitherto known. The ground colour is light pink, as in some other species *e. g.*, *C. nutans* and *C. pendula* Ag.[1] but differing in this respect from *C. carnea* Clarke[2] (coral-red) and also from *C. nana* Alder[3] (white or yellowish). On the swollen part of the hypostome, on the hydranth-basis, and along the boundary between the non-papillated upper and the papillated lower regions of the hydrocaulus, a deep pink colour with a yellowish tint is prominent. A fine streak of the same color is found on the inner side of each proximal tentacle. Numerous small round or elliptical spots of a light red colour are scattered over the non-papillated region of the hydrocaulus, more thickly in the lower half of this region. The general features and characteristic color-markings of the hydrosome may be seen in fig. 1, which represents one of the larger specimens drawn from life. Here it must be noted that the proportion of the different regions of the hydrocaulus is not always the same as is shown in the figure. But the figure will give a fairly good idea of an average individual fully expanded. The filament-tuft borne by the proximal bulbous end of the hydrocaulus is represented in the figure in a greatly reduced state

Hydranth. In the majority of the larger specimens the hydranth is 8–10 mm. in diameter at the base. The proximal tentacles, 38–40 in number and 12–15 mm. long, are arranged in a single circlet. In the number of the tentacles the species agrees well with *C. carnea.* The distal tentacles are much shorter, more slender and more numerous (about 70) than those just mentioned, and are arranged in 6–7 verti-

1) Agassiz,—Contributions to the Natural History of the United States. (Vol. 4, 1862).
2) Clarke, S. F.,—The Hydroids of Alaska (published by the Academy of Natural Sciences in Philadelphia), 1872; An Alaskan Corymorpha-like Hydroid. (Proc. of the U. S. Nat. Mus., vol. 26, 1903).
3) Hincks, T.,—A History of the British Hydroid Zoophyte. (London, 1868).

ciles as in *C. nutans*. The gonosomes, which arise from the hyposomal basis just above the proximal tentacular row, are comparatively long (7-10 mm.) and slightly thicker than proximal tentacles. They are not very contractile, so that they remain almost unchanged in length after being killed. The number of the gonosomes vary to some extent according to age of the hydroid; in the larger individuals it ranges from 8 to 15. They are arranged in a single circlet. All the specimens examined by me possessed 8-11 medusa-bearing gonosomes, the rest being still rudimentary and devoid of medusæ. The number and arrangement of the above organ clearly distinguish the species from its nearst from, *C. nutans*, which has 15-20 gonosomes arranged in two alternate rows. The stem of a full grown gonosome gives off 10-15 short branches, which all lie on the outer side of the stem in two alternate rows. To the free end of such a side branch a certain number of medusoid gonophores are attached in a cluster. The latter are in quite various stages of development (fig. 2), some being simple bud-like prominences, others being bell-shaped, and still others already bearing a single tentacle. The general shape of the umbrella resembles considerably that of *C. palma* Torrey,[1] but the manubrium is nearly as long as the umbrella. Some old medusae still in attachment have the mouth and long, somewhat moniliform tentacles, but seem to be destitute of gonads. Unfortunately such advanced medusae dropped off and were lost when killed.

As is the case with other *Corymorpha* species as well as with *Branchiocerianthus* and many tubularian hydroids, the hydranth-cavity is divided into an upper and a lower, less spacious compartment (fig. 3, *hp. c.* and *l. h. c.*). The two cavities communicate with each other, as was pointed out by Allman in *C. nutans*, by means of a narrow vertical passage. This canal-like passage is produced, it may be said, by an extensive development of the thick parenchymatous tissue (*p. t.*)

1) Torrey H. B.,—Biological Studies on Corymorpha; II The Development of C. palma from the Egg. (Univ. of Calif. Public., Zool., vol. 12, 1907).

roofing the lower cavity. The septal structures separating the two hydranth-cavities as also that which separtes the lower hydranth-cavity from the hydrocaulus-cavity, are essentially the same as in *Tubvloria* and *Branchiocerianthus*. The upper septum is supported interiorly by a membraneous sheet of the mesoglœa arising from that of the body-wall just inside the row of proximal tentacles. The upper surface of the septum is lined by the glandular endoderm, while the lower surface, *i. e.*, the roof of the lower cavity, is made up of the parenchymatous endoderm. The latter projects in the middle of the upper surface of the septum in the form of a small protuberance. The lower septum, or the perforated membrane of Torrey, and its mesoglœal support are far less developed than the upper septum and its supporting membrane respectively. The upper surface of the septum is lined by a thin sheet of pacenchyme. Thus, both the channel and the lower hydranth-cavity differ from those of *C. nutans*, as described by Allman in being lined entirely by parenchymatous, instead of glandular, endoderm. In the present species the glandular endoderm is, so far as concerns the hydranth, confined to the hypostomal cavity and its gonosomal prolongation (fig. 3, *gs.*). The glandular endoderm forming the floor of the hypostomal cavity is always radially folded so as to produce a large number of ridges arranged with some regularity in relation to proximal tentacles.

Apparently peculiar to the present form is a structure, which is found in the hypostomal endoderm and which produces certain free cells (Fig. 3, *l. gl.*). It is situated between the gonosomal and tentacular (proximal) rows in the form of a narrow ring measuring about 0.11 mm. in breadth. The zone is easily detected in sections as a remarkably thin and highly stainable epithelium. Under a high power of the microscope one finds that the epithelium here consists of a compact mass of polygonal cells of a remarkably small size (7 μ in diameter) and having finely granular and highly staining cytoplasm. Those cells lying in contact with the mesogloea are somewhat taller

and are arranged in a more or less regular row, while those in the mass are polygonal owing to mutual pressure (fig. 4). further, the cells near the free surface are roundish and loosely aggregated; and those most internally situated are quite free, presenting a spherical shape. Free cells of strikingly similar nature to those just mentioned are found not only in the vicinity of the glandular epithelium, but also in a large number in every part of the hydranth-cavity, in gonosomal-cavities as well as in longitudinal canals of the hydrocaulus. All these free cells are readily distinghuishable from ordinary tissue-cells by their small size and their remarkably small nucleus. Nevertheless, the nucleus is structurally quite the same as that of tissue-forming cells, *i. e.*, it has a distinct nuclear membrane, peripheral chromatin granules, and a central nucleolus. Thus there is little doubt that the wandering cells referred to are derived, so to say, budded off, from the zone of the modified epithelium in question, Most wandering cells, especially those in the hyposomal cavity, are found to differ slightly from the cells composing, or in the vicinity of, the formative epithelium, in being of a larger size and in showing a feebler staining capacity. Judging from the results of differential staining, it is plain that the swelling of the wandering cells is apparently due to imbibition of fluid, which accumulates in the narrow space between the pellicle and the periplasma. The cytoplasm of such wandering cells is also characterized by containing a few minute granules of a brown color. Various sorts of such cells, which I take to represent degenerating stages, are abundantly met with in the hypostomal cavity mingled with food detritus. Although I take it for certain that the modified epithelium of the hypostomal endoderm gives rise to those wandering cells, yet it is altogether uncertain whether or not the cells arise by mitosis from the epithelial cells, since division figures have not been met with in any part of the structure in both adult and young individuals.

Hydrocaulus. The hydrocaulus becomes gradually narrower to-

wards the hydranth-basis and thicker towards the bulbous end invested with filaments. Its non-papillated and papillated parts are externally sharply demarkated from each other by the characteristic colored ring. A close examination reveals the fact that the boundary corresponds with the lower end of the perisarc, which is found in the papillated region. The relative lengths of the two regions vary a great deal with the state of contraction of the parts; when fully extended, the non-papillated region makes up nearly one-third the length of the entire hydrocaulus. The ten longitudinal canals are seen through the integument. Anastomosis between these canals is not so frequent as in *C. nutans*, *C. pendula* or *C. nana*; it occurs in the non-papillated region at four or five places at most, and most frequently near its lower end. The papillae are arranged nearly in the same way as in other known forms, forming, as they do, two apparently alternating longitudinal rows along each canal. Their number and the mode of distribution vary considerably with different individuals; generally speaking, they are most thickly and regularly distributed in the middle part of the papillated region, though in many individuals they may be found uniformly over the greater part of the papillated region. The papillæ become gradually larger and taller downwards, and finally at the cuticular bulb they take the form of moderately long threads ending with a small swelling.

As to the internal anatomy of the hydrocaulus, there is little to be added to the observations of previous writers. The ten longitudinal canals coalesce anteriorly into a common cavity, the central space of which is occupied by a parenchymatous mass. The outer endodermal wall of the longitudinal canal consists of a single layer of conspicuously tall epithelial cells, while all the remaining parts consist of the parenchyme. It is to be noted that the epithelial cells contain numerous spherical granules which are uniformly scattered throughout the finely granular cytoplasm.

It need scarcely be mentioned that the papillæ consist of

three layers, the ectoderm, the endoderm and the mesoglœa; they are nothing other than outbulgings of the body-wall. In a quite small papilla, the cytoplasm of the ectodermal cells is homogeneously granular; the outer part of it stains considerably deeper. The mesoglœa is only feebly developed as compared with that of the general body-wall. Inside the mesogloea is a sigle row of endodermal cells which proximally pass over insensibly into the epithelium of longitdinal canals. At the apex of papillae we find a narrow space which invariably shows a flattened endodermal cell closely applied to the mesoglœa. The same space is found also in the more elongated papillæ. As the papilla grows longer, ectodermal cells with much cytoplasm become restricted to the tip only, they being replaced in other parts by those with coarsely reticulated cytoplasm. The axial endodermal cells become more vacuolated towards the basis of papilla. Finally let it be only added that ectodermal cells differ greatly in their character in the papillated and non-papillated regions, as has already been observed by other writers.

To compare the present form with other species of the genus:

1). *Corymorpha nutans* Sars is undoubtedly more closely allied to the present species than any others. However, several important points of difference are to be noticed: in coloration of the hydrosome, the number of proximal tentacles, the number and arrangement of gonosomes, the shape of the medusa-umbrella, the mode of anastomosis of longitudinal canals in the hydrocaulus, *etc.*

2). *Corymorpha nana* Alder differs markedly from the present species in being of a diminutive size and of a white or yellowish color, in the less number of tentacles of both sorts (16-18 distal tentacles in two imperfect rows and 15-20 proximal tentacles), and in sessile or unbranched gonosomes.

3). *Corymorpha carnea* Clarke differs from the present species in being of a coral-red color and in having about 30 gonosomes.

Also in other respects, the two species differ widely from each other. *C. carnea* may be said to resemble more closely the next species.

4). *Corymorpha pendula* Agassiz is distinguished from the present species by its bright color, by the gonosomes numbering about 30, and by the more frequently anastomosing longitudinal canals of hydrocaulus.

5). *Corymorpha palma* Torrey exhibits several noticeable peculiarities which are not found in the present species; for instance, the nearly colorless hydrosome, proximal tentacles numbering less than 30, the medusa devoid of any tentacle and having a manubrium of considerable length (at least twice as long as the height of umbrella), *etc.*

6). *Corymorpha appeloefi* Bonnevie[1] is a remarkable form with rudimentary tentacles

Budding in Corymorpha tomoensis.[2]

While Mr. Arii was examining some preserved specimens of *C. tomoensis* he discovered among the tangled mass of the filaments of basal bulb a very small individual (fig. 5), which in a degree resembled the adult *Corymorpha*. Later careful search has led to the discovery of some thirty small individuals in various stages of development. Fig. 5 represents the youngest stage with four distal and seven proximal tentacles; fig. 6 a much more advanced stages provided with ten distal and seventeen proximal tentacles.

Whether or not these young animals were really those budded off from the adult *Corymorpha*. was a question of high interest to me. In vain have I tried to get information on the subject from the literature. Dr. Torrey of the California University has kindly informed me that he also had often observed similar small animals attached to the filaments of adults, but was inclined to believe that they were always

1). Bonnevie, Kr.,—Hydroiden (Meeresfauna von Bergen, 1901); in Zool. Centralbl., Jahrg. 8, 1901, pp. 464-465.

2). The fuller account of the budding will be published later.

simply attached to the filaments. It is, indeed, a very difficult task to trace a bud-bearing filament to the adult hydrocaulus, because of the entangled condition of the delicate filaments. Nevertheless, I was lucky enough to have observed indubitable cases of organic connection existing between the bud and the filament of the mother animal. However, owing to the very delicate nature of the bud-filaments, the buds easily fall off while handling, so that I have not been able to sketch one standing in direct continuity with a filament of the adult. As is the case with ordinary full grown filaments, the greater part of a bud-bearing perisarc is usually nearly quite empty. Sometimes the slender perisarc tube adjoining the bud is seen to give off a few delicate filamentous processes (fig. 6.) and to contain remnants of disintegrated cœnosarc in the form of wavy or discontinuous solid cords of varying thickness (fig. 7).

In order to observe the budding in a more conclusive way, I went last April to Abutozaki, where in September 1907 *Corymorpha tomoensis* was found in abundance. Unfortunately, all my efforts to rediscover the species were in vain, not coming across even a single specimen. According to the fisherman who accompanied me, Mr. Owatari, Professor of Biology in the Okayama Higher School should have collected in July 1908 a large number of specimens of the species at a spot near Kajiko Island and about 7 miles off to east of Tomo. The majority of his specimens were said to have been much smaller than those collected by me before at Abutozaki in the month of September. Kajiko-Island was also visited by me during April last, but an entire day's search ended without bringing a single specimen under observation. After all my experience I am inclined to assume that the hydrosome annually perishes, probably during the winter.

Should the filamentous appendices on the hydrocaulus of *Corymorpha* be homologous with the creeping hydrorhiza of other forms as Torrey asserts[1], the budding from the filaments seems to fall in the

1. H. Torrey; The Hydroids of the Pacific Coast of North America, 1902, p. 43.

ordinary category of Hydrozoan asexual reproduction.

Judging from the stages I have collected, the buds of the present species may be said to be practically of the same structural plan as *Corymorpha palma* described by Torrey. It is very much to be regreted that the present investigation could not be extended to the early stages of the bud development.

The earliest stage (fig. 5) that came under my observation is about 1.3 mm. long. It already shows the definitive shape of a hydrosome; both the hydrocaulus and hydranth are well diffenentiated. The former is, as already remarked, provided with four distal and seven proximal tentacles, but is as yet without any gonosomal rudiment; the latter shows four longitudinal canals each ending proximally with a rudimentary papilla. Sections of the stage show conditions sumilar to what Torrey has described of the corresponding stage of young *C. palma*. The hydranth-cavity is alredy divided into the upper (hypostomal) and the lower cavity by the characteristic endodermal septum; also a second septum, the fenestrated membrane of the adult, is already present but is not yet perforated. A point worth mentioning is that even in such an early stage there is the rudiment of the free-cell forming structure located just above the insertion of the septum. There one notices a narrow zone (about 20 μ in width) of the hypostomal endoderm, which is represented by a remarkably thin epithelium (about 6μ thick) consisting of a row of cubical and deeply staining cells (5-7 in a longitudinal section). As the buds grow larger, both sorts of tentacles gradually increase in number; so also the longitudinal canals and the papillæ on hydrocaulus. In an intermediate stage bearing seven distal and fourteen proximal tentacles, a single gonosome was found in the incipient condition, there being present the definitive mouth and the perforated membrane while the longitudinal canals numbered as yet only four. The rudiment of the lymphoid stucture remians in this stage in nearly the same state as in the youngest stage observed by me,

excepting that the constituent cells have become slightly taller and more numerous. The oldest development alstage obtained is represented in fig. 6. It measures about 2.5 *mm.* in length, and shows essenltialy the same feature as the adult; six gonosomal prominences, the upper hydranth-septum and the lower fenestrated membrane, have come into more distinct existence; the longitudinal canals have much increased in number (at least 8), and the most proximally situated papillæ have assumed a filamentous shape. The first indication of the increase in thickness is seen at this stage in the epithelium of the future free-cell forming struture. Fig. 8 represents a portion of a sagittal section through the hydranth of the oldest bud; in it the epithelium in question is seen as a layer two-cells thick, which is sharply differentiated from other cells of the endoderm by its deeply staining capacity.

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Explanton of Plate V.

Fig. 1. A full-grown hydrosome. Enlarged 1 $^1/_2$ times.

Fig. 2. A side-branch of gonosome bearing a cluster of medusoid buds in various stages of development. Greatly magnified.

Fig. 3. Semidiagrammatic representation of the median longitudinal section of the hydranth and of a part of the hydrocaulus, Greatly magnified.

d. t., distal tentacle; end. c., endodermal core; g. s, gonosome; hy. c., hypostomal cavity; l c. longitudinal canal of hydrocaulus; l. gl., lymphoid gland; l. h. c., lower hydranth-cavity; p. t., proximal tentacle; p. y., parenchyme; u. h. c., upper hydranth-cavity.

Fig. 4. A small portion of a section of the lymphoid struture of an adult animal. Highly magnified.

Fig. 5. Youngest bud observed, with four distal and seven proximal tentacles.

Fig. 6. Oldest bud observed, with ten distal and seventeen proximal tentacles; already provided with six gonosomal rudiments.

Fig. 7. Magnified view of a stained hydrocaulus close to the free end of hydrocaulus.

Fig. 8. A small portion of the median longitudinal section of the hydranth wall of the bud represented in Fig. 6. Highly magnified.

ect., ectoderm; end., endoderm; l. gl., lymphoid gland; sp, septum.